UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/989,367	11/20/2001	Oscar E. Agazzi	41281/NJP/B600	1105

23363 7590 08/31/2005

CHRISTIE, PARKER & HALE, LLP
PO BOX 7068
PASADENA, CA 91109-7068

EXAMINER	
TORRES, JUAN A	

ART UNIT	PAPER NUMBER
2631	

DATE MAILED: 08/31/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/989,367	Applicant(s) AGAZZI, OSCAR E.	
	Examiner Juan A. Torres	Art Unit 2631	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 August 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-46,49 and 50* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-46,49 and 50* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12 August 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Specification

The modifications to the specification were received on 08/12/2005. These modifications are accepted by the Examiner.

Claim Objections

In view of the amendment filed on 08/12/2005, the Examiner withdraws claim objections of claim 6 of the previous Office Action.

Claim Rejections - 35 USC § 112

In view of the amendment filed on 08/12/2005, the Examiner withdraws the 35 USC § 112 rejections to claims 47 and 48 of the previous Office Action.

Response to Arguments

Applicant's arguments filed on 08/12/2005 have been fully considered but they are not persuasive.

Regarding claims 1-22:

The Applicant contends, "Sands does not disclose "sampling the data after it has passed through the channel to produce a sampled value" as set forth in claims 1 and 11".

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Sands discloses sampling the data after it has passed through the channel to produce a sampled value (figure 1 y_k pages 6-7 section 2.1). Specifically Sands indicates:

> For practical purposes, we will deal with a sampled version of $y(t)$ at some arbitrary multiple ρ of the symbol rate $1/T$. The ith sample in the kth symbol period is then
>
> $$y\,(t = (k + i/\rho)T) = y_{k,i}.$$

For these reasons and the reasons indicated in the previous Office Actions the rejections to claims 1-22 are maintained.

Regarding claims 23 and 30:

The Applicant contends, "claim 23 now recites in part: "adapting the estimating in the nonlinear channel estimator in accordance with the decisions." In addition, claim 30 now recites in part: "a nonlinear channel estimator . . . adapts the estimating in accordance with the decisions." Accordingly, Applicant respectfully submits that independent claims 23 and 30 are not obvious in view of the cited references.".

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Sakaguchi discloses a method for equalizing an optical signal, modulated with a digital signal, received over an optical channel comprising converting the optical signal into an electrical signal (figure 1 column 4 lines 25-58). Sakaguchi doesn't specifically disclose summing the electrical signal with a correction signal; providing the summed signal to a detector; detecting the summed signal to produce decisions; providing the decisions to a nonlinear channel estimator; and estimating the correction signal in the nonlinear channel estimator. Bellini discloses an equalizer summing the electrical signal with a correction signal (figure 2 page 935 section 3.2); providing the summed signal to a detector (figure 2 Viterbi detector page 935 section 3.2); detecting the summed signal to produce decisions (figure 2 $\hat{a}_n$ page 935 section 3.2); providing the

decisions to a nonlinear channel estimator (figure 3 page 935 section 4); and estimating the correction signal in the nonlinear channel estimator (figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 23 and 30. For these reasons and the reasons indicated in the previous Office Actions the rejections to claims 1-22 are maintained.

Regarding claim 24:

The Applicant contends, "claim 24 recites in part: "predicting the inter-symbol interference of the channel in a nonlinear channel estimator." In contrast, in Figure 3 of Bellini a "third adaptive filter with M taps subtracts an estimate of the ISI on the central track." ".

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Bellini discloses predicting the inter-symbol interference of the channel in a nonlinear channel estimator (figure 3 pages 935-936 section 4). For these reasons and the reasons indicated in the previous Office Actions the rejections to claim 24 is maintained.

Regarding claim 28:

The Applicant contends, "Claim 28 recites in part: "providing the data decisions as an address into a look up table" and "outputting a value stored in the look up table as the predicted inter-symbol interference." Bellini makes no mention of a look-up table that outputs the predicted inter-symbol interference.".

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Bellini discloses providing the data decisions as an address into a look up table (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4). For these reasons and the reasons indicated in the previous Office Actions the rejections to claim 28 is maintained.

Regarding claim 37:

The Applicant contends, "Bellini does not teach or suggest "estimating, in a non linear channel estimator, the expected values" and "computing the branch metrics based on the expected values of the received signal" as claimed in claim 37".

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Bellini discloses a method for decoding a signal received over an optical channel, the method comprising receiving a signal including linear and non linear components (figure 2 page 935 section 3.2)

> To realize an adaptive Maximum Likelihood Sequence Estimator (MLSE) in the case of linear channels, we can use an adaptive Matched Filter (MF) followed by a Viterbi Detector (VD) [9]. To extend the MLSE structure to the nonlinear optical channel, we add a Non-Linear Canceller (NLC), for nonlinear ISI suppression. Once nonlinear distortion is canceled, the VD can compute metrics the usual way. The combination of the NLC, the adaptive MF and the VD leads to the NMLSE [5].

; estimating, in a non linear channel estimator, the expected values of the received signal (figures 2 and 3 pages 935-936 sections 3.2 and 4. Figure 3 discloses the non-linear maximum likelihood sequence estimator generating the output)

A simplified block diagram of the XT canceller is shown in Fig. 3. Note that all delays are understood. For instance, the estimates $\{\hat{a}_{1n}\}$ and $\{\hat{a}_{2n}\}$ of symbols stored in the adjacent tracks are produced with a delay equal to $(N-1)/2$, where N is the length of the adaptive NAVEs, fed by the samples r_{1n} and r_{2n}. Another delay is produced by the NAVE (or NMLSE) that takes the final decisions $\hat{a}_{un}$. Hence, also the error signal used to update the coefficients of all the adaptive filters is delayed, and must be multiplied by delayed replicas of estimated data.

Linear combinations of the (nonlinearly) estimated data $\{\hat{a}_{1n}\}$ and $\{\hat{a}_{2n}\}$, obtained through two adaptive filters with N coefficients that try to reproduce the interference from neighboring tracks, are subtracted from the samples r_n of the main track. We have not considered more complex XT cancellers, taking into account also products of $\{\hat{a}_{1n}\}$, $\{\hat{a}_{2n}\}$ and of the (estimated) data along the central track, so far. This work is in progress.

A third adaptive filter with M taps subtracts an estimate of ISI of the central track. We found that ISI cancellation eases the identification of the coefficients of the XT canceller.

; computing the branch metrics based on the expected values of the received

signal (figure 2 page 935 section 3.2 first paragraph)

To realize an adaptive Maximum Likelihood Sequence Estimator (MLSE) in the case of linear channels, we can use an adaptive Matched Filter (MF) followed by a Viterbi Detector (VD) [9]. To extend the MLSE structure to the nonlinear optical channel, we add a Non-Linear Canceller (NLC), for nonlinear ISI suppression. Once nonlinear distortion is canceled, the VD can compute metrics the usual way. The combination of the NLC, the adaptive MF and the VD leads to the NMLSE [5].

. For these reasons and the reasons indicated in the previous Office Actions the rejections to claim 37 is maintained.

Regarding claim 39:

The Applicant contends, " claim 39 recites in part: "providing the value of the received signal as an address to a look up table" and "looking up the stored value as the actual value transmitted." Bellini makes no mention of a look-up table used for "looking up the stored value as the actual value transmitted."

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Bellini discloses providing the value of the received signal as an address to a look up table (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4)

> The NMLSE considered here has an adaptive matched filter with $N = 5$ linear taps and an NLC with $N^2 = 25$ nonlinear ones. Weights are updated according to the LMS algorithm, with step size equal to 10^{-3} for linear taps, and 10^{-5} for nonlinear ones. The decision delay, i.e., the trellis length that is kept in memory, is $L = 30$, and $S = 128$ trellis states are considered. The cross talk canceller is the same as in the previous case.

> The weights in the above equation are adaptively updated, for instance according to the Least Mean Square (LMS) algorithm. This equalizer structure is known as Nonlinear Adaptive Volterra Equalizer (NAVE) [6], and is a nonlinear extension of MSE equalization.

; and looking up the stored value as the actual value transmitted (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4). For

these reasons and the reasons indicated in the previous Office Actions the rejections to claim 39 is maintained.

> The NMLSE considered here has an adaptive matched filter with $N = 5$ linear taps and an NLC with $N^2 = 25$ nonlinear ones. Weights are updated according to the LMS algorithm, with step size equal to 10^{-3} for linear taps, and 10^{-5} for nonlinear ones. The decision delay, i.e., the trellis length that is kept in memory, is $L = 30$, and $S = 128$ trellis states are considered. The cross talk canceller is the same as in the previous case.

> The weights in the above equation are adaptively updated, for instance according to the Least Mean Square (LMS) algorithm. This equalizer structure is known as Nonlinear Adaptive Volterra Equalizer (NAVE) [6], and is a nonlinear extension of MSE equalization.

Regarding claim 40:

The Applicant contends, “Bellini does not teach or suggest "a non linear channel estimator that computes the expected values of the received signal" and "a branch metrics computer for computing the branch metrics based on the expected values of the received signal" as claimed in claim 40”.

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Bellini discloses a method for decoding a signal received over an optical channel, the method comprising receiving a signal including linear and non linear components (figure 2 page 935 section 3.2); estimating, in a non linear channel estimator, the expected values of the received signal (figures 2 and 3 pages 935-936 sections 3.2 and 4); computing the branch metrics based on the expected values of the received signal

(figure 2 page 935 section 3.2 first paragraph). For these reasons and the reasons indicated in the previous Office Actions the rejections to claim 40 is maintained.

Regarding claims 43 and 46:

The Applicant contends, "submits that independent claims 43 and 46 are not obvious in view of the cited references since the combination of these reference does not teach or suggest all of the limitations of the claims.".

The Examiner disagrees and asserts, that, as indicated in the previous Office Action Sakaguchi discloses a method for detecting digital data modulated on an optical signal and received over an optical channel, the method comprising converting the optical signal to an electrical signal (figure 1 column 4 lines 25-58); converting the electrical signal to a multibit digital representation (figure 1 column 4 lines 25-58); estimating distortion introduced in the optical signal by the optical channel (figure 1 column 4 lines 25-58). Sakaguchi doesn't specifically disclose compensating the multibit digital representation for the distortion; and detecting the digital data from the compensated multibit digital representation. Bellini discloses compensating the multibit digital representation for the distortion (figure 2 page 935 section 3.2); and detecting the digital data from the compensated multibit digital representation (figure 2 $\hat{a}_n$ page 935 section 3.2. The output will be digital and will comprise multiple bits!). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce

the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 43 and 46. For these reasons and the reasons indicated in the previous Office Actions the rejections to claims 43 and 46 are maintained.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-22 are rejected under 35 U.S.C. 102(b) as being anticipated by Sands ("Non-linear identification on the digital magnetic recording channel", Twenty-Fifth Asilomar Conference on Signals, Systems and Computers, 4-6 Nov. 1991 Page(s):6 - 10 vol.1).

As per claim 1 Sands discloses a method for modeling the behavior of a data channel the method comprising determining a sequence of data input to the data channel (figure 1 x_k pages 6-7 section 2.1); using at least part of the sequence of data input to the data channel as an index to a channel model value (figure 1 x_k pages 6-7 section 2.1); sampling the data after it has passed through the channel to produce a sampled value (figure 1 y_k pages 6-7 section 2.1); comparing the channel model value with the sampled value (figure 1 y_k - $\hat{y}_k$ pages 6-7 section 2.1); and adjusting the channel model value based on the results of the comparison between the channel model value and the sampled value (page 9 section 2.6).

As per claim 2 Sands discloses determining a sequence of data input to the data channel comprises determining the last N bits input to the channel (figure 1 x_k pages 6-7 section 2.1).

As per claim 3 Sands inherently discloses where N=5 (pages 6-7 section 2.1).

As per claim 4 Sands discloses that the sampling of the data after it has passed through the channel to produce a sampled value comprises producing a real number representing the sampled value ($y_{k,i}$ pages 6-7 section 2.1).

As per claim 5 Sands discloses adjusting the channel model value further comprises adjusting the channel model value according to an LMS (Least Means Squared) algorithm (page 9 section 2.6).

As per claim 6 Sands discloses adjusting the channel model value further comprises adjusting the channel model value until it converges (page 9 section 2.6).

As per claim 7 Sands discloses comprising converting the look up table into Volterra Kernels (pages 6-7 section 2.1).

As per claim 8 Sands discloses converting the look up table into Volterra Kernels using a Hadamard transform (page 7 section 2.2).

As per claim 9 Sands discloses adjusting the Volterra Kernels based on the results of the comparison between the channel model value and the sampled value (page 9 section 2.6).

As per claim 10 Sands discloses eliminating the insignificant Volterra Kernels (pages 7-8 section 2.4).

As per claim 11 Sands discloses a method for modeling the behavior of a data channel the method comprising determining a sequence of data input to the data channel (figure 1 x_k pages 6-7 section 2.1); determining a Volterra Series representation of the channel (figure 1 pages 6-7 section 2.1); accepting at least part of the sequence of data input to the data into the Volterra series representation of the channel to produce a channel model value (figure 1 pages 6-7 section 2.1); sampling the data after it has passed through the channel to produce a sampled value (figure 1 y_k pages 6-7 section 2.1); comparing the channel model value with the sampled value (figure 1 y_k - $\hat{y}_k$ pages 6-7 section 2.1); and adjusting the channel model value based on the results of the comparison between the channel model value with the sampled value (page 9 section 2.6).

As per claim 12 Sands discloses accepting a most recent value of the sequence of data input to the data channel (x_k pages 6-7 section 2.1); accepting the most recent value of the sequence of data input to the data channel into a first FIR (Finite Impulse Response) filter (page 9 section 3); accepting a product of the most recent value of the sequence of data input to the data channel and a second most recent value of the sequence of data input to the data channel into a second FIR (page 9 section 3); and summing an output of the first FIR and output of the second FIR to form the channel model value (page 9 sections 2.6 and 3).

As per claim 13 Sands discloses accepting a most recent value of the sequence of data input to the data channel (x_k pages 6-7 section 2.1); accepting the most recent value of the sequence of data input to the data channel into a first FIR filter (page 9

section 3); accepting a product of the most recent value of the sequence of data input to the data channel and the second most recent value of the sequence of data input to the data channel into a second FIR (page 9 section 3); accepting a product of the most recent value of the sequence of data input to the data channel and a third most recent value of the sequence of data input to the data channel into a third FIR (page 9 section 3); and summing an output of the first FIR and output of the second FIR and output of the third FIR to form the channel model value (page 9 sections 2.6 and 3)

As per claim 14 Sands discloses accepting a most recent value of the sequence of data input to the data channel (x_k pages 6-7 section 2.1); accepting the most recent value of the sequence of data input to the data channel into a first FIR filter (page 9 section 3); accepting a product of the most recent value of the sequence of data input to the data channel and the second most recent value of the sequence of data input to the data channel into a second FIR (page 9 section 3); accepting a product of the most recent value of the sequence of data input to the data channel and a third most recent value of the sequence of data input to the data channel into a third FIR (page 9 section 3); accepting a product, the product being the most recent value of the sequence of data input to the data channel and the two next most recent data input, into a fourth FIR (page 9 section 3); and summing an output of the first FIR and output of the second FIR and output of the third FIR and output of the fourth FIR to form the channel model value (page 9 sections 2.6 and 3).

As per claims 15-18 Sands discloses the difference between the channel model value and the output of the channel is used to update all the FIRs (page 9 section 2.6).

As per claims 19-22 Sands discloses that an LMS algorithm is used to update all the FIRs (page 9 section 2.6).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 23-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakaguchi (US 4747094) and further in view of Cancellation of Bellini ("Nonlinear cross talk cancellation for high density optical recording", Global Telecommunications Conference, 1999. GLOBECOM '99 Volume 1B, 1999 Page(s): 933 - 938 vol. 1b).

As per claim 23 and 30 Sakaguchi discloses a method for equalizing an optical signal, modulated with a digital signal, received over an optical channel comprising converting the optical signal into an electrical signal (figure 1 column 4 lines 25-58). Sakaguchi doesn't specifically disclose summing the electrical signal with a correction signal; providing the summed signal to a detector; detecting the summed signal to produce decisions; providing the decisions to a nonlinear channel estimator; and estimating the correction signal in the nonlinear channel estimator. Bellini discloses an equalizer summing the electrical signal with a correction signal (figure 2 page 935 section 3.2); providing the summed signal to a detector (figure 2 Viterbi detector page 935 section 3.2); detecting the summed signal to produce decisions (figure 2 $\hat{a}_n$ page 935 section 3.2); providing the decisions to a nonlinear channel estimator (figure 3 page

935 section 4); and estimating the correction signal in the nonlinear channel estimator (figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 23 and 30.

As per claims 24 and 31 Bellini discloses accepting the decisions (figure 3 pages 935-936 section 4); predicting the inter-symbol interference of the channel in a nonlinear channel estimator (figure 3 pages 935-936 section 4); and forming a correction signal from the predicted inter-symbol interference (figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 24 and 31.

As per claims 25 and 32 Bellini discloses providing the decisions to a plurality of Volterra Kernels (page 934 section 3.1 and figure 3 pages 935-936 section 4); and summing the output of the plurality Volterra Kernels to form a correction signal (page

934 section 3.1 and figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 25 and 32.

As per claims 26 and 33 Bellini discloses comparing the predicted inter-symbol interference to inter-symbol interference in the electrical signal (page 934 section 3.1 and figure 3 pages 935-936 section 4); and updating the Volterra Kernels based on the result (page 934 section 3.1 and figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 26 and 33.

As per claims 27 and 34 Bellini discloses using a LMS (Least Means Squared) algorithm to update the Volterra Kernels (page 934 section 3.1 and figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed

by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 27 and 34.

As per claims 28 and 35 Bellini discloses providing the data decisions as an address into a look up table (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4); outputting a value stored in the look up table as the predicted inter-symbol interference (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4); comparing the predicted inter-symbol interference to the inter-symbol interference in the electrical signal (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4); and updating the value stored in the look up table based on the result (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 28 and 35.

As per claims 29 and 36 Bellini discloses using a LMS (Least Means Squared) algorithm (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3

pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 29 and 36.

As per claims 37 and 40 Bellini discloses a method for decoding a signal received over an optical channel, the method comprising receiving a signal including linear and non linear components (figure 2 page 935 section 3.2); estimating, in a non linear channel estimator, the expected values of the received signal (figures 2 and 3 pages 935-936 sections 3.2 and 4); computing the branch metrics based on the expected values of the received signal (figure 2 page 935 section 3.2 first paragraph); providing the computed branch metrics to a Viterbi decoder(figure 2 page 935 section 3.2 first paragraph); and Viterbi decoding the received signal using the branch metrics provided to the Viterbi decoder (figure 2 page 935 section 3.2 first paragraph). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore,

it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 37 and 40.

As per claims 38 and 41 Bellini discloses providing the value of the received signal to a Volterra kernel estimator (figure 2 page 935 section 3.2 first paragraph); and computing the expected value sent based on the output of the Volterra kernel estimator (figure 2 page 935 section 3.2 first paragraph). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 38 and 41.

As per claims 39 and 42 Bellini discloses providing the value of the received signal as an address to a look up table (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4); and looking up the stored value as the actual value transmitted (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini

page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 39 and 42.

As per claims 43 and 46 Sakaguchi discloses a method for detecting digital data modulated on an optical signal and received over an optical channel, the method comprising converting the optical signal to an electrical signal (figure 1 column 4 lines 25-58); converting the electrical signal to a multibit digital representation (figure 1 column 4 lines 25-58); estimating distortion introduced in the optical signal by the optical channel (figure 1 column 4 lines 25-58). Sakaguchi doesn't specifically disclose compensating the multibit digital representation for the distortion; and detecting the digital data from the compensated multibit digital representation. Bellini discloses compensating the multibit digital representation for the distortion (figure 2 page 935 section 3.2); and detecting the digital data from the compensated multibit digital representation (figure 2 $\hat{a}_n$ page 935 section 3.2). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 43 and 46.

As per claims 44, 47 and 49 Bellini discloses estimating in a Volterra Kernel estimator the distortion introduced in the optical channel (figure 2 page 935 section 3.2). Sakaguchi and Bellini are analogous art because they are from the same field of

endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 44, 47 and 49.

As per claims 45, 48 and 50 Bellini discloses estimating in a lookup table estimator the distortion introduced in the optical channel (page 937 first paragraph section 5.2, page 934 section 3.1 and figure 3 pages 935-936 section 4). Sakaguchi and Bellini are analogous art because they are from the same field of endeavor. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate in the optical channel receiver disclosed by Sakaguchi nonlinear estimator disclosed by Bellini. The suggestion/motivation for doing so would have been to reduce the nonlinear ISI (Bellini page 933 section 1). Therefore, it would have been obvious to combine Sakaguchi with Bellini to obtain the invention as specified in claims 45, 48 and 50.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Juan A. Torres whose telephone number is (571) 272-3119. The examiner can normally be reached on Monday-Friday 9:00 AM - 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mohammad H. Ghayour can be reached on (571) 272-3021. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Juan Alberto Torres, Ph. D.
08-21-2005

KEVIN BURD
PRIMARY EXAMINER